REMARKS:

General

Applicants have rewritten all the claims to define the invention more particularly and distinctly so as to overcome the technical rejections and define the invention patentably over the prior art. All these claims are based on what have been shown in both the specification of record and the substitute specification.

Independent claim 10 describes a novel apparatus for routing address lookup, which incorporates an associative memory array together with a novel deterministic address entries categorization method implemented through the applicants' new content comparable memory (CCM) device. Any particular memory bank of the content addressable memory banks is only activated if the routing address is deterministically known to be in that memory bank, which saves the power consumed by the apparatus. The results achieved are new, unexpected and have never been suggested before.

Dependent claim 11 adds the implementation of the categorization of the address entries based on prefix lengths. In addition to the benefits realized through claim 10, this removes the need to use ternary CAM arrays and also priority encoders inside each CAM bank, which results in smaller apparatus sizes and higher operation speeds.

Dependent claim 12 recites one embodiment of realizing the prefix length categorization of the address entries in hardware.

Dependent claim 13 extends the implementation recited in claim 10 up one level, from memory bank level to the monolithic integrated device level, with the same benefits and advantages.

Dependent claims 14-15 recite same matters as claims 11 and 12, this time with the additional matter of claim 13.

Independent claim 16 recites a novel apparatus for comparing two binary words in magnitude, which is named a Content Comparing Memory (CCM) by the applicants. The implementation results in a compact device which is small enough to be called a memory cell. It is not much

larger than a binary CAM cell and it is about the same size as a ternary CAM cell. The compactness of the cell allowed the inventors to use the cell extensively in the overall invention. The resulting cell is new, unexpected and has never been suggested before.

Dependent claims 17-27 add various permutations of the following limitations to the independent claim 16: - The memory cell storing both the bit and its inverse, - having an inverter to create the logical inverse of the stored bit, - delivering the inverse of the search binary bit to the cell, and - the logic devices inside the memory cells being implemented through transmission gates.

Independent claim 28 recites a method for routing address lookup, which incorporates a novel deterministic address entries categorization method. Any particular memory bank of a device, which uses this method, will be only activated if the search routing address is deterministically known to be in that memory bank, which saves the power consumed for the routing address lookup. Same as claim 10, the results achieved are new, unexpected and have never been suggested before.

Dependent claim 29 extends the categorization method recited in claim 28 up one level, from memory bank level to the monolithic integrated device level, with the same benefits and advantages.

Independent claim 30 adds the method of categorization of the address entries based on prefix lengths. In addition to the benefits realized through claims 28 and 29, this eliminates the need to use priority encoders inside memory banks to resolve multiple prefix length matches, resulting in higher operation speeds.

Independent claim 31 recites essentially the same method for routing address lookup as claim 28, but it extends the method to any hierarchy of storage and search elements in an address lookup search engine.

Independent claims 32-34 recite various methods to compare two binary words in magnitude using the CCM apparatus recited in claims 16-27. Due the novelty of the CCM cell, the methods for using it are also novel and therefore patentable.

The Objection to the Disclosure Due to Informalities (items 1&2 in the office action)

The claims have been rewritten, with care taken to avoid informalities. The specification has also been substituted with a more appropriate format.

The Rejection of Claims 1-9 under 35 U.S.C. §102(a) as Being Anticipated by Miyatake et al (item 4 in the office action)

In their paper, Miyatake et al. show a CAM cell with PMOS match-line drivers instead of the usual NMOS drivers. This choice results in a lower swing on the matchlines, which reduces the power consumption. It also results in certain benefits in the precharge levels of bitlines and matchlines. Miyatake et al. also show a match sense amplifier with an NMOS passgate between its input and the matchline to further reduce the swing on the matchlines. The NMOS passgate also makes sure that the matchline PMOS switches do not leak in off state, as their gate is driven to vdd-vtn, rather than full vdd.

This application's new claims 10-15 and 28-31 show novel apparatus and methods thereof for routing address lookup, based on what have been shown in both the specification of record and the substitute specification. Claims 28-31 recite methods for deterministically activating only certain portions of an associative memory based lookup search engine during a lookup operation. Claims 10-15 recite the architecture to implement the methods in claims 28-31 in hardware. What are recited in these claims are not shown by Miyatake et al.

New claims 16-27 and 32-34 show novel apparatus and methods thereof for a compact content comparing memory (CCM). Using this memory cell and the method described in the claims, a search entry can be compared in magnitude with the contents of the memory. This memory accomplishes this task while its size remains small such that it can be easily integrated on a monolithic integrated device. This device is used in the implementation of the apparatus and methods thereof recited in claims 10-15 and 28-31. Again there is no mention of such a device in the paper by Miyatake et al.

Parts of dependent claims 11, 12, 14, 15 and independent claim 30 recite categorizing the address entries based on prefix lengths. Although Miyatake et al. mention this in their paper, they do not combine it with other novel features cited in the above-mentioned claims. Therefore, these claims recite a novel combination and are patentable.

Based on the observations above, applicants submit that the new claims 10-34 clearly recite novel subject matter which distinguishes over what is anticipated by Miyatake et al.

The Rejection of Claims 1-9 under 35 U.S.C. §102(e) as Being Anticipated by US 6,665,297 (Hariguchi et al) (item 5 in the office action)

In their patent, Hariguchi et al. show a new network routing table architecture which has the following features: 1- It uses hash circuits in parallel with content addressable memory (CAM) arrays. 2- it divides address space based on prefix lengths among the hash circuits and CAM arrays. 3- it uses a new method for hashing operation.

They do not show the novel apparatus and methods thereof for routing address lookup recited in claims 10-15 and 28-31. They also do not show anything which resembles the CCM apparatus and method thereof recited in claims 16-27 and 32-34.

Hariguchi et al. show the categorization of the address entries based on prefix lengths. As explained in the Miyatake et al. case above, this categorization is recited in dependent claims 11, 12, 14, 15 and independent claim 30 together, but it is in combination with other novel features not shown by Hariguchi et al. Therefore, these claims recite a novel combination and are patentable.

Hariguchi et al. also show the use of mask memory arrays for the implementation of the above-mentioned categorization. Dependent claims 12, and 15 recite the utilization of a mask memory array, but again they do so in combination with other novel features not showed by Hariguchi et al. Therefore, these claims recite a novel combination and are patentable.

Based on the observations above, applicants submit that the new claims 10-34 clearly recite novel subject matter which distinguishes over what is anticipated by Hariguchi et al.

Other Prior Art Made of Record and Not Relied Upon in This Office Action

Other references cited in the office action (paper by McAuley et al. and US patent by Muller et al) have been reviewed by the applicants.

McAuley et al. discuss various usages of binary and ternary CAM arrays in address lookup. In some of the methods, they show the categorization of the address entries based on prefix lengths.

Muller et al. discuss a general architecture for a network switch, which includes: 1- A packet header processing unit, 2- a search engine using a regular CAM array. They recite using mask bits in one implementation of the CAM search engine.

None of these references show applicants' invention or render it obvious.

CONCLUSION

For all the above reasons, applicants respectfully submit that the specification and claims are now in proper form, and that the claims all define patentability over the prior art. Therefore, they submit that this application is now in full condition for allowance, which action they respectfully solicit.

Conditional Request for Constructive Assistance

Applicants have amended the specification and claims of this application so that they are proper, definite, and define novel structure and method which are also unobvious. If, for any reason, this application is not believed to be in full condition for allowance, applicants respectfully request the constructive assistance and suggestions of the Examiner pursuant to M.P.E.P. § 2173.02 and § 707.07(j) in order that the undersigned can place this application in allowable condition as soon as possible.

Very Respectfully,

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Enclosed:

- A substitute specification in clean form without the markings as to amended material.

- A marked-up copy of the substitute specification showing the matter being added to and the matter being deleted from the specification of record.

- New sheets 1/6 to 6/6 of drawings.

DRAWINGS:

The amendments to the drawings are enclosed at the end of this amendment.

Fig.1 and Fig. 2 on sheet 1/6 are newly added. They are added for clarifying some of the points made in the specification and include no new matter.

Fig. 3 on sheet 2/6 is the same as Fig. 1 in the original submission.

Fig. 4 on sheet 3/6 is the same as Fig. 2 in the original submission.

Fig. 5 on sheet 4/6 is the same as the top portion of Fig. 5 in the original submission.

Fig. 6 on sheet 5/6 is the same as the bottom portion of Fig. 5 in the original submission.

Fig. 7 on sheet 6/6 is the same as Fig. 6 in the original submission.

Drawings Amendment